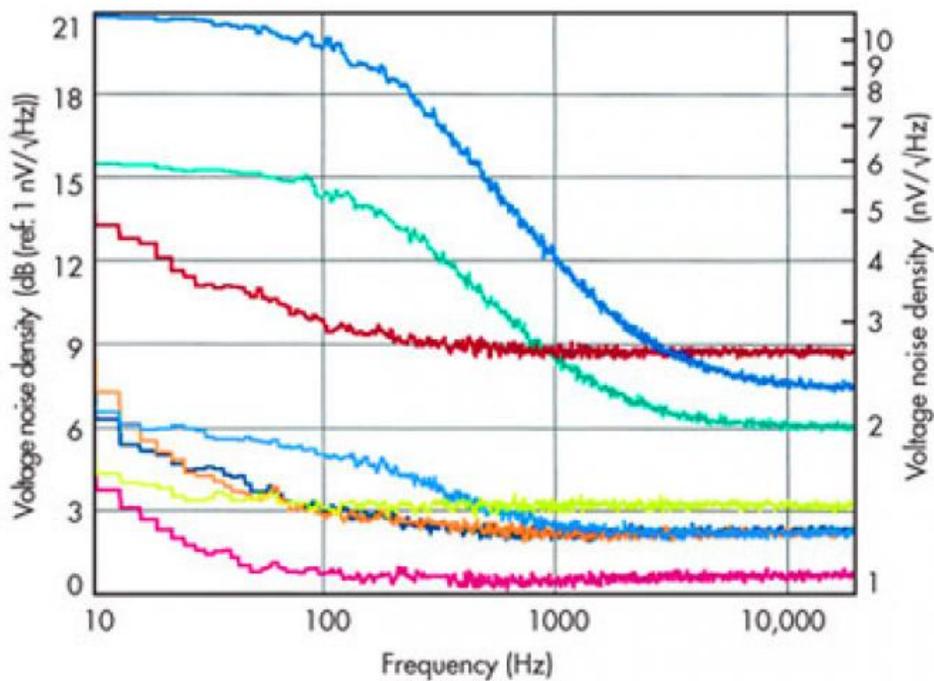


## ELECTRONIC DESIGN



TECHNOLOGIES > POWER

### Measurements Rate SMT Low-Voltage n-JFETs Under Consistent Conditions

*This article presents apples-to-apples test results for noise densities for several low-noise discrete, SMT n-JFETs. The tests used the same operating conditions so that designers can make a fair comparison for their applications.*

Dimitri Danyuk | Apr 19, 2013

Designers use preamplifiers with JFET input devices in applications that require both low voltage noise and high input impedance, such as vibration, acoustic, and ultrasound sensors, optoelectronic devices, bioelectric data acquisition, and semiconductor noise measurement.

Fortunately, some JFET-input operational amplifiers exhibit remarkably low noise densities, including the AD743 (3.2 nV/√Hz at 1 kHz),<sup>1</sup> the OPA827 (4 nV/√Hz at 1 kHz),<sup>2</sup> the LT1792 (4.2 nV/√Hz at 1 kHz),<sup>3</sup> and the OPA1641 (5.1 nV/√Hz at 1 kHz).<sup>4</sup>

When a JFET preamplifier with even lower noise is required, a discrete input device is the only solution. While the variety of JFETs on the market is shrinking year after year, some devices with an equivalent noise voltage density below 3 nV/√Hz at 1 kHz are available from the major electronic parts distributors.

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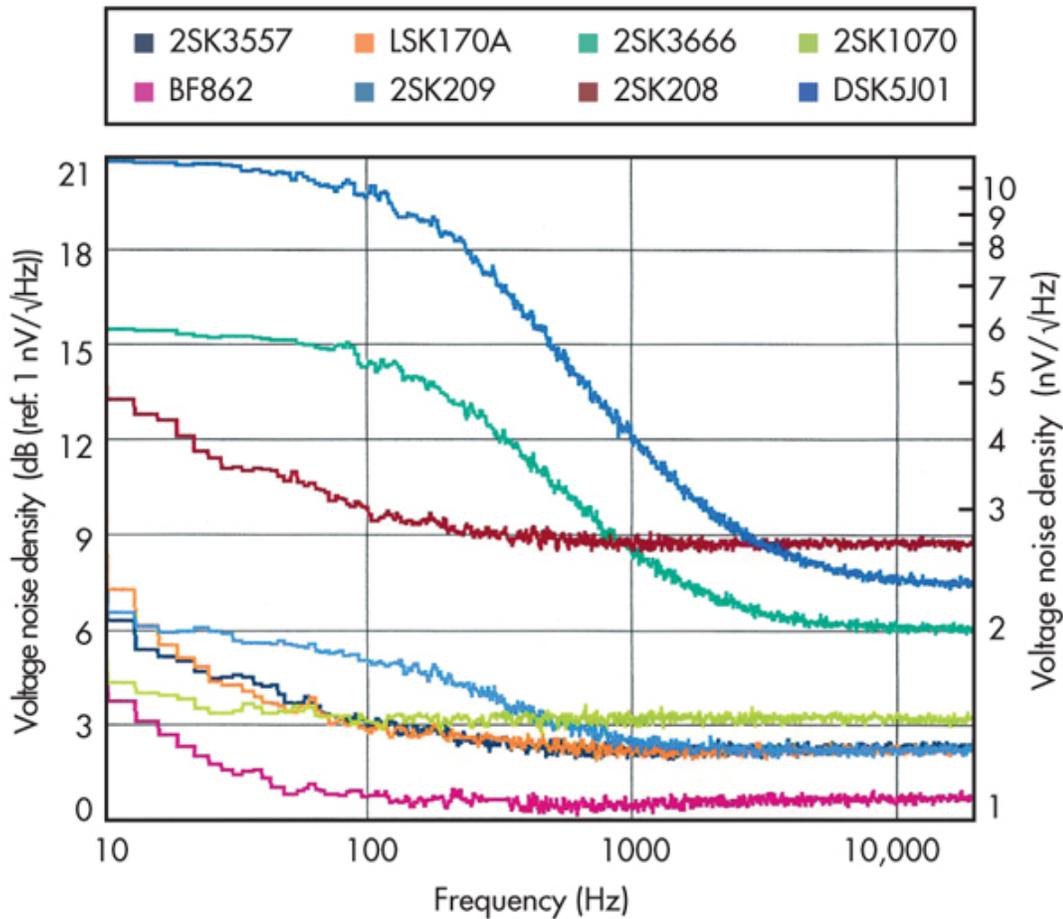
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However, it's hard to compare noise specifications for devices from different manufacturers because some mention equivalent input noise (EIN) voltage and some use noise factor (NF). Also, noise is measured under different operating conditions (drain current,  $I_D$ , and drain-source voltage,  $V_{DS}$ ). And, the measurement frequency varies between devices.

To help designers compare discrete surface-mount (SMT) n-JFET devices, we measured voltage noise under consistent conditions using a low-noise measurement system.<sup>5</sup>  $I_D$  was 1 mA,  $V_{DS}$  was 2.5 V, and ambient temperature,  $T$ , was 25°C. The thermal resistance of the SOT23 package is about 200°C/W, so the 2.5-mV power dissipation rise in junction temperature is negligible. We measured 16 samples of each device and averaged the noise data from 10 Hz to

20 kHz of 1/f and thermal noise. The table and figure show the results.



Noise measurements of a number of discrete SMT n-JFETs under consistent operating conditions show that several are suitable for applications that demand very low voltage noise.

MEASURED NOISE FOR SMT N-JFET				
Part number	Voltage noise density, $E_N$ (nV/√Hz at 1 kHz)	Equivalent noise resistance, $R_{EQ-N}$ (Ω)	Equivalent input noise voltage, $R_G = 0$ , 22-22 kHz (dBV)	Equivalent input noise voltage, $R_G = 0$ , 22-22 kHz, A-weighted (dBV)
BF862	1.1	75	-135.6	-138.3
LSK170A	1.3	105	-133.9	-136.6
2SK208Y	2.75	460	-127.2	-129.9
2SK209Y	1.3	105	-133.9	-136.6
2SK3557-7	1.3	105	-133.9	-136.6
2SK3666-3	2.7 (2 at 10 kHz)	440 (250 at 10 kHz)	-129.3	-132.1
2SK1070	1.4	120	-133.1	-135.6
DSK5J01	4.0 (2.4 at 10 kHz)	1000	-127.1	-129.8

$R_G$  = signal source resistance  
 $I_D = 1$  mA,  $V_{DS} = 2.5$  V,  $T = 25^\circ\text{C}$

Five devices available from different manufacturers exhibited voltage noise densities from 1.1 to 1.4 nV/√Hz: the BF862, LSK170A, 2SK209Y, 2SK3557-7, and 2SK1070. All of them are

high-gain (transconductance/forward transfer admittance,  $Y_{FS} = 5$  to  $45$  mA/V) devices with moderate drain current ( $I_{DS} = 1.2$  to  $40$  mA). Another three JFETs (2SK208Y, 2SK3666-3, and DSK5J01) showed higher noise. These devices have smaller transconductance ( $Y_{FS} = 1.2$  to  $6.5$  mA/V) and lower input capacitance CISS. If a lower noise is required, you can connect JFETs in parallel or use a much more expensive specialized device. Noise measurements for extremely low-noise ( $0.3$ - $0.5$  nV/ $\sqrt{\text{Hz}}$ ) boutique JFETs (the IF9030, IF1801, and IF3601) can be found in Reference 5.

## Acknowledgement

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